NOTES, ABSTRACTS, AND REVIEWS

SOLAR AND TERRESTRIAL RELATIONSHIPS

The first Report of the Commission appointed by the International Research Council to further the study of solar and terrestrial relationships has been received. English and French texts are each printed in full. The body of the report consists of memoranda which form an invaluable summary of the present state of knowledge of the subject and of the outlook for further research. We reprint here a part of the introductory section and three memoranda touching solar relationships with terrestrial weather.

(5) On reviewing present knowledge of the phenomena which the committee are charged to study, they conclude that the principal terrestrial phenomena which are definitely known to be affected by intrinsic changes in the state of the sun, or by changes in the presentation of the sun toward the earth (owing to the solar rotation), are as follows:

(*a*) The magnetic state of the earth and earth currents.
(*b*) Aurorae.
(*c*) Meteorological and climatic changes.

They conclude also that the following phenomena are not improbably affected by the aforesaid solar changes, but that there is need for further series of observations in order that the matter may be thoroughly investigated.

(*d*) Atmospheric electricity (potential gradient and general ionization of the atmosphere).
(*e*) Radio-telegraphic transmission.

They conclude further that the following phenomena are sufficiently likely to be affected by such solar changes to require further investigation from this standpoint:

(*f*) The amount of ozone in the upper air.
(*g*) The extra-polar auroral light.
(*h*) High-level atmospheric absorption.
(*i*) Penetrating radiation in the atmosphere.
(*j*) The light of the night sky.

(6) The committee consider that the principle variable solar phenomena which can be definitely asserted to affect terrestrial conditions are as follows:

(*k*) The general radiation of the sun.
(*l*) Local disturbance on the sun, as manifested by sunspots, faculae, and prominences.
(*m*) The general march of the solar cycle.

They conclude also that the following solar phenomenon probably affects terrestrial conditions, but that this has not yet been established:

(*n*) Solar disturbance manifested by intense local magnetic fields, but without visible markings.

They conclude further that the following solar phenomena are sufficiently likely to affect terrestrial conditions to warrant further investigation from this standpoint:

(*o*) The alternation of the magnetic polarity of sunspots in successive eleven-year cycles.
(*p*) Absorbing matter ejected from the sun, such as is indicated by photographs of the corona and of prominences.

Notes on the Relationship of Solar and Terrestrial Phenomena

551.590.2

By C. G. ABBOT

1. THE VARIATION OF SOLAR RADIATION

It seems to be well established that the sun's output of radiation is variable. The variations appear to be irregular in time and amount. They are associated, apparently, with changes in the sun's visible features. Numerous sunspots and great activity accompany a high level of the solar constant, and vice versa. But the passage of a spot or group of spots across the central solar meridian near the equator is almost invariably followed, the next day, by a minimum of the solar constant. From a comparison of Smithsonian solar work with too few determinations of Saturn's brightness, by Guthnick, it appears probable that this effect of central passage of sun-spots means that rays of diminished transparency emanate nearly radially from the sun and rotate with its rotation. Consequently, the effects pass rapidly along and reach one planet after another in order of their heliocentric longitudes. Further investigations of the brightness of the planets ought to be made to test this hypothesis.

The magnitude of solar changes seldom exceeds 5 per cent, but the total range of fairly weighty solar constant values thus far observed exceeds 10 per cent.

The investigation of solar variation is difficult and costly. The Smithsonian Institution is not assured of funds to maintain it after July, 1925. The sources of error are so insidious that long experience is almost indispensable. It is greatly to be hoped that financial means will be found to continue the two Smithsonian stations, now in operation, without a break in their records for many years.

2. INFLUENCE OF SOLAR VARIATION ON METEOROLOGY

Mr. H. H. Clayton has given by far the most study to this question. His published results in his book, World Weather, are notable, but his unpublished results, which I have had the opportunity to see, are even more notable. Hardly anything except the continuance of the two Smithsonian stations, I believe, would be better worth while than to give Mr. Clayton an adequate number of computers, and the assistance of one or or two young men of good parts and training, so that he might devote the years remaining to him effectively to this investigation and leave trained disciples to continue it.

Referring to Figure 193, page 231, of Clayton's World Weather, it is to be noted that the solar changes found by Smithsonian observers in Chile were very closely parallelled, without appreciable lag in time, in the barometric pressure at Sarmiento, Argentina. They may have been a few hours' lag of the barometric curve, but certainly much less than one day. How can this correlation, in the sense high solar constant, high barometric pressure, be explained? It is not reasonable to suppose the sun's variation acts directly on the barometric pressure. It must act indirectly through the temperature. As the atmosphere absorbs a large proportion of the solar rays, from 15 per cent up, according to conditions, and as the atmosphere has but small capacity for heat, its temperature response to solar changes must be almost immediate. In this respect, we must note a distinction between the atmosphere as a whole and the layer close to the ground which is influenced to a considerable extent by slowly changing ground temperatures.

The direct influence of increase of solar radiation being to warm the atmosphere, it would tend to expand it. Thus, air would flow from regions of high atmospheric absorption to those of lower. Since barometric pressure at Sarmiento appears to increase with increasing solar constant, the inference would be that this station, which lies in an arid region about 60 miles from the Atlantic Ocean, has a clearer, less absorbing atmosphere than its surroundings. There would be great interest in tracing such conditions in other regions, with a view to establishing real relations between solar variations and terrestrial conditions.

Memorandum on the Study of Solar Radiation and Meteorology

551.5:551.590.2

By G. C. SIMPSON

As all movement in the atmosphere depends ultimately on energy received from the sun mainly in the form of solar radiation, it goes without saying that the meteorologist is vitally interested in variations, periodic and secular, in the sun's radiation.

Investigators up to the present have used two methods of attack on the problem of the relationship between the sun and the weather. In the first, sunspots have been taken to be an indication of solar activity and variations in terrestrial weather corresponding with variations in sunspots have been sought. The 11-year solar period has played the predominating part in all such investigations. The second method has made use of the data made available by the work of Abbot and his coworkers. Abbot's measurements have made it possible to follow from day to day the changes in the solar radiation received on the confines of our atmosphere, and several investigators, chief amongst them being Clayton, have attempted to correlate these with meteorological factors.

Speaking broadly, one must say that the results up to the present have been disappointing. Clear and definite relationships have not been found between sunspots and weather similar to those which have been found in the case of terrestrial magnetism. The 11-year period is certainly recognizable in some meteorological factors, but in very few cases is the amplitude of any practical importance. The investigations into the day-to-day variations of solar radiation have been little more successful, although Mr. Clayton has exhibited many interesting and suggestive curves.

It is practically impossible to work out a priori what effect an increase in solar activity would have on the weather of any given place. It is generally admitted that temperature would rise in some areas and fall in others, and even this varies with the season. The general circulation of the atmosphere would no doubt be intensified, but what changes in the distribution of pressure and rainfall this would involve can not be stated. It is also not certain that an increase in solar radiation results in more radiation reaching the earth's surface, for the upper atmosphere may at the same time become more opaque to solar radiation.

All these problems require investigation but nothing can be done without absolutely reliable information about the solar radiation. There are plenty of meteorological data for most problems, it is the solar data which are lacking.

In order to obtain the information required, there should be more stations in different parts of the world repeating the work done at Washington, Mount Wilson (Calif.), Montezuma (Chile), and Harqua Hala (Ariz.), so that errors due to the earth's atmosphere may be detected and eliminated. This would give satisfactory information regarding the energy received on the confines of the atmosphere. We need, in addition, measurements of the radiation received at the earth's surface. This is a much more difficult problem. Instruments and methods are available, but the practical difficulties of making the measurements and interpreting the results are very serious. So far as I know, there does not exist at present a single series of measurements from which it is possible to determine the periodic and secular variations, over any extended period, of the solar energy received at the earth's surface.

With regard to the former—the measurement of the solar radiation outside the atmosphere—the work requires a special observatory with expensive instruments and specialized staff. It is, therefore, primarily work to be undertaken by governments. In the present financial state of the world it will be difficult, but probably not impossible, to get governments to undertake the expense; the committee might do something in this direction.

The measurement of the radiation received at the earth's surface is not such an expensive matter. What is required is an agreemenl on the instruments and methods which will give the best results and provision made for the comparison of different instruments. Then instruments must be installed where they will be kept in constant and careful use, so that homogeneous series of data may, in the course of a few years, be available for statistical investigations.

Solar Relations with Weather

By Sir Gilbert T. Walker

Apart from the effects of variations in the solar constant from day to day upon meteorological conditions, upon which H. H. Clayton is working, there are relationships between monthy and seasonal data of the solar constant or sunspot numbers on the one hand and of rainfall, pressure, or temperature on the other; thus the correlation coefficient between sunspots and the annual temperature of India, as given by the data of 47 years, is as high as -0.5. These relationships strongly suggest that at times of increased solar activity there is increased opacity to heat radiation both within the earth's atmosphere and outside it in regions where the ordinary extrapolation is ineffective; such questions clearly deserve study.

An extension of determinations of the solar constant to new countries is highly desirable; and it would be of great value if an independent method, such as that of photometry, could be applied. The measures of Jupiter's brightness from 1878 to 1890 by Müller, of Potsdam, were promising, as was the suggestion by Evershed of studying the brightness of the moon.

LATE ICE IN LAKE ERIE

Mr. J. H. Spencer, of the Buffalo Weather Bureau Office, has sent us information on the extraordinary ice conditions in Lake Erie before and during the very late opening of navigation this year. The following notes and excerpts are of interest:

At the end of April ice fields approximately 35 miles long occupied the eastern end of the lake except for small patches of open water along the Canadian side. The first attempt to break through the ice was made on April 30 by three freighters, which got only 5 miles out of Buffalo before being stuck fast for a week. On May 6, 18 ships attempted the passage and on the 7th 18 more, and on the following days yet more.

It was not until May 9, at 1:25 p. m., that navigation was finally opened by the arrival of the freighter *W. A. Reiss* from Chicago, followed by 13 others, which laboriously had broken their way through the heavy ice fields. Ten of the west-bound fleet of 55 vessels reached open water on May 10.

The almost unprecedented coldness of this spring was responsible for this historic battle with the ice. The mean temperature for March was 4.3° F. below normal, and for April 7.8° F. below. April's monthly mean temperature of 35.0° F. was the lowest for this month at Buffalo since 1874; hence the ice did not disintegrate in April as usual. Moreover, strong NE. winds were almost absent in April and May, and consequently were of no help in breaking up the ice in the eastern end of the lake.

This note appears in our Daily Local Record of May 26: "There are still great fields of soft ice in this end of Lake Erie. Inbound and outbound vessels plow through it with great difficulty. Accidents are frequent, and numerous vessels have been damaged by ice, the damage being confined chiefly to wheels and rudders."

"There were great quantities of ice in the lake on May 31. * * * On June 1, however, it had almost disappeared as though by magic. After two postponements, the lake passenger season between Detroit and Buffalo was opened on June 2 * * *. These unprecedented conditions caused great money loss to the port of Buffalo and to the commerce of the Great Lakes, due in part to the damage of vessels, but chiefly to the late opening of navigation."

WEATHER BUREAU STAFF MEETINGS, 1925–26

By Edgar W. Woolard, Secretary

The regular biweekly meetings of the scientific and technical staff of the Central Office of the United States Weather Bureau, initiated in the autumn of 1923, have been continued on the same plan as heretofore, during the winter of 1925–26. Following is a list of the discussions (asterisks denote speakers from outside the Weather Bureau); meetings during previous seasons have been reported in the Monthly Weather Review, 1924, **52,** 35–36, 166, and 1925, **53,** 264.

September 30, 1925

W. J. Humphreys. Report on proceedings of the Babson conference on long-range weather forecasting.

October 7, 1925

A. J. Henry. Monthly pressure variations in the northern hemisphere, and their bearing on seasonal weather forecasting.

C. L. Mitchell. The accuracy of forecasts made from variations in solar radiation.

October 21, 1925

Discussion of G. C. Simpson's paper on "The New Ideas in Meteorology."

November 4, 1925

**G. Breit.* The Kennelly-Heaviside layer.

November 18, 1925

**H. U. Sverdrup.* Meteorological observations off the coast of Siberia during the *Maud* expedition.

December 2, 1925

W. R. Gregg. Atmospheric discontinuities, permanent and temporary.